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Soil Investigation in Batu – Batu Village: Geotechnical Analysis

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A R T I C L E I N F O

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A B S T R A C T

Soil Investigation work in Batu-batu Village, Muara Badak District, was carried out to evaluate the condition of soil density and characteristics in the field through a series of tests, such as the Sondir Test (Dutch Cone Penetrometer Test), DCP Test (Dynamic Cone Penetrometer), Sandcone Test, Proctor Standard, and CBR Quarry. This investigation aims to obtain real-time data that will be used as the basis for designing foundations and other geotechnic-related infrastructure. Soil testing directly in the field provides critical information regarding the carrying capacity of the soil, which is crucial to prevent structural failures in construction projects, such as building subsidence or collapse. Literature studies reveal that soil investigation is an important step before starting a construction project, as described in research by Bowles (1996) and Das (2008), which highlights the importance of in-situ testing to obtain more accurate data than laboratory testing. However, previous studies have generally focused on other locations, and specific research on soil characteristics in Batu Batu Village has not been conducted in detail. Therefore, this study is important to provide accurate and specific data for foundation design at the site

INTRODUCTION

Soil Investigation, Sondir Test (Dutch Cone Penetrometer Test), DCP Test (Dynamic Cone Penetrometer), Sandcone Test, Proctor Standard & CBR Quarry work located in Batu-batu Village, Muara Badak District, is carried out to provide information on soil density conditions, in the field.

To see the condition of the soil in the field, a direct soil investigation was carried out in the field (Field Soil Investigation). The data obtained from the test results will be used as the basis for foundation construction work or construction related to Geotechnics.

This test is carried out to obtain real-time data on soil conditions at the project site, which will be used as the basis for designing foundations and other infrastructure. Without a proper understanding of the carrying capacity of the soil, construction projects are at risk of structural failure, such as subsidence or collapse.

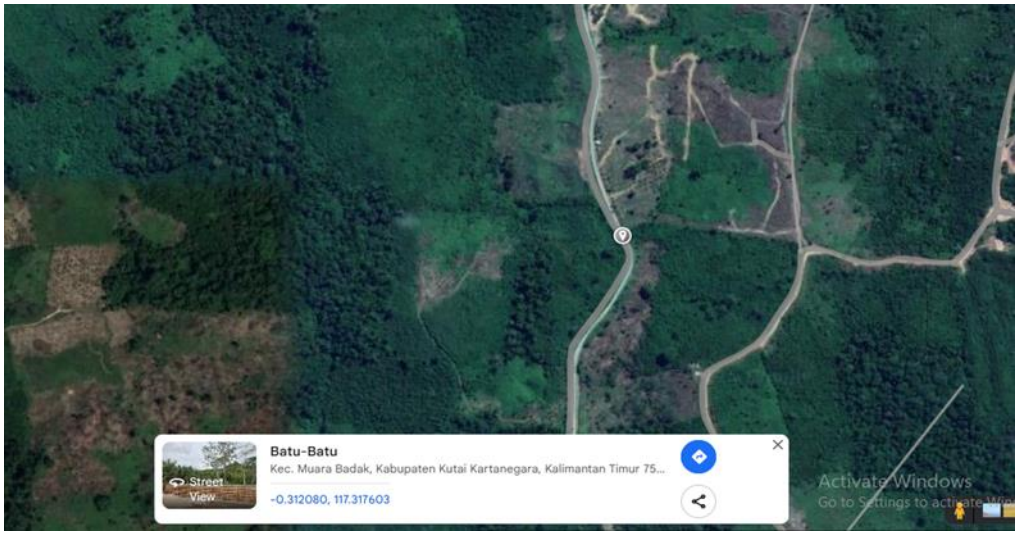
However, a common gap is the lack of specific data for a particular location. Each site has different soil characteristics, and previous research has generally focused on other areas. For Batu-batu Village, Muara Badak District, there has been no detailed research on soil characteristics, so this research is very relevant and important

LITERATURE REVIEW

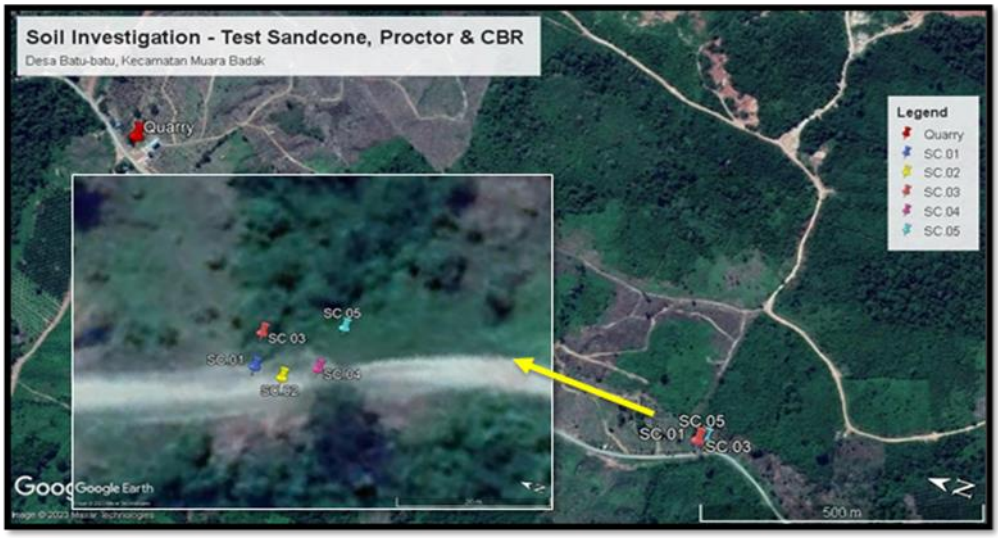
Many previous studies have discussed the importance of soil investigation before starting a construction project. For example, research by Bowles (1996) explains that soil carrying capacity and soil density are critical factors in determining effective foundation design. A study by Das (2008) also emphasized that in-situ testing such as Sondir, DCP, and Proctor Standard provides more accurate data than pure laboratory testing.

METHODOLOGY

Soil Testing is located in Batu-batu Village, Muara Badak District, Kutai Kartanegara Regency with coordinates 0.311986, 117.317500. This area is characterized by oil palm plantations and coal mining with concrete roads that facilitate transportation. Batu Village - Batu itself is an area that continues to grow,. Infrastructure development, such as Road construction and improvement requires in-depth study because of the varied soil conditions, ranging from sandy soils to clay soils, which affect the selection of foundation types. In addition, the region is affected by tropical weather with high rainfall, which can affect soil stability, especially during the rainy season. Therefore, soil testing at this location is very important to determine the safe and efficient carrying capacity of soil for infrastructure development,. Here are the locations of the test points:



Gambar 1. Lokasi Pengujian



Gambar. 2. Lokasi Titik Pengujian

1. Research Methods

Soil testing work is carried out to determine the condition of the soil carrying capacity at the project site, as a basis for supporting development facilities and infrastructure, where real soil data will be obtained in the field at this time Static penetration testing, This test is to obtain parameters - parameters of the value of Conus Resistance, shear resistance / Local Resistance, total shear / total resistance, cumulative total shear / Accumulative total resistance (JHL) & shear appeal number / Friction ratio is carried out at each soil depth to the specified soil depth, (SNI 2827- 2008/ASTM D3441).

2. Test sander (Dutch no penetrometer test)

This test is to obtain the parameters of Conus Resistance, Shear Resistance, Total Friction, Total Friction, Accumulative Total Resistance (JHL) & Friction ratio which is carried out at each soil depth up to the specified soil depth, (SNI 2827- 2008/ASTM D3441).

Pile Foundation Support with Schmertmann Method

The Schmertmann method is one of the commonly used methods to calculate the bearing capacity of piles based on sondir test data. In this method, the bearing capacity of the drill pile is calculated as a combination of the bearing capacity of the pile end (Qp) and the bearing capacity due to the adhesion or friction of the pile with the soil (Qs). The formula used is:

$$Qu = Qp + Qs$$

Where:

Qu = Ultimate bearing capacity of the pile (kg or ton)

Qp = End bearing capacity is calculated from the results of the cone resistance test.

Qs = Bearing capacity due to the resistance of adhesion or soil friction along the surface of the pile (skin friction)

For the allowable carrying capacity (Qi), the safety factor is used to calculate the safe carrying capacity, namely:

$$Qi = Qp / Fk1 + Qs / Fk2$$

Where:

Fk1 = Safety factor for pile ends (used 3)

Fk2 = Safety factor for adhesion resistance (used 5)

Shallow Foundation Support Capacity

Shallow foundation bearing capacity According to Sanglerat (1972) developed a simple approach to calculate the allowable bearing capacity of shallow foundations based on the cone resistance value of the sondir test. This method makes it easy to determine a shallow foundation without considering the adhesive resistance (Qs). The formula is:

$$Qi = CR / 10$$

Where:

Qi = Allowable shallow foundation bearing capacity (kg/cm^2 or ton/m^2)

CR = Cone resistance value from sondir test (kg/cm^2)

The Sanglerat method only takes into account the resistance of the cone tip, so it is suitable for Shallow foundations work in less deep layers of soil.

RESULTS AND DISCUSSION

According to Prof. Ir. Indrasurya B. Mochtar, MSc, PHd (2006) correlates the Sondir Test (CPT) score for the consistency of silt and clay dominant soils as follows:

Table 1. Classification of Soil Types Based on Conus Value (Kg/Cm²)

No	Soil Type	Conus value (kg/cm2)
1	Very Soft	0 – 10
2	Soft	10 – 20
3	Medium	20 – 40
4	Kaku (Stiff)	40 – 75
5	Very Stiff	75 – 150
6	Keras (Hard)	> 150

This Conus Value is Obtained from the Sondir Test (Cone Penetration Test / CPT), Which is Used To Assess the Hardness or Consistency of the Soil. According to Schmertmann (1978) Correlates the Sondir Test (CPT) Score For The Consistency Of Sandy Soil

Table 2. Is a Classification of Soil Consistency Based on the Value of CPT Qu (Cone Penetration Test – Uncorrected Cone Resistance)

No	Soil Consistency	CPT qu (KN/m2) (Meyerhof 1974)	CPT qu (kg/cm2)
1.	Very Loose	0 – 2000	0 - 20
2.	Lepas (Loose)	2000 – 5000	20 – 50
3.	Medium	5000 – 15000	50 – 150
4.	Solid (Dense)	15000 – 25000	150 – 250
5.	Very dense	25000 – 40000	250 – 400

Based on the Meyerhof (1974) Method. CPT is Used to Assess The Density or Strength of Sandy Soils and Other Granular Materials

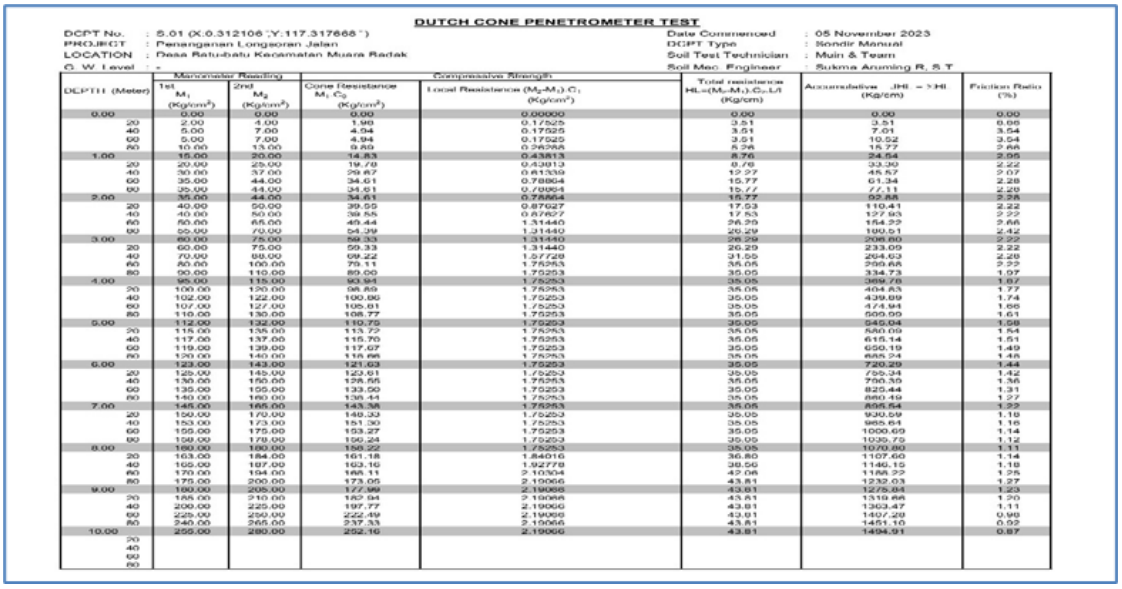
Field Test Results

After soil testing was carried out at the location in Batu-batu Village, Muara Badak District. then the following results were obtained:

Table 3. Recapitulation of Sondir Test Results

No.	Titik	Depth (m)	Cone Resistance Konus (Kg/Cm2)	Accomulative JHL (kg/cm)	Ket
1	S.01	1.00	14.83	24.54	Bright
		5.00	110.75	545.04	
		10.00	252.16	1494.91	
2	S.02	1.00	14.83	24.54	Bright
		5.00	79.11	343.50	
		10.00	148.33	1219.76	
		15.00	250.18	2236.23	
3	S.03	1.00	14.83	29.79	Bright
		5.00	98.89	574.83	

		10.00	158.22	1451.10	
		12.00	251.17	1864.69	



DUTCH CONE PENETROMETER TEST

DCPT No. : S.01 (X:0.312106 °;Y:117.317668 °)
PROJECT : Penanganan Longsoran Jalan
LOCATION : Desa Batu-batu Kecamatan Muara Badak
G. W. Level : -

Date Commenced : 05 November 2023
DCPT Type : Sondir Manual
Soil Test Technician : Muin & Team
Soil Mec. Engineer : Sukma Aruming R, S T

DEPTH (Meter)	Manometer Reading 1st M_1 (Kg/cm²)	Manometer Reading 2nd M_2 (Kg/cm²)	Cone Resistance $M_1 \cdot C_2$ (Kg/cm²)	Compressive Strength Local Resistance $(M_2-M_1) \cdot C_1$ (Kg/cm²)	Total resistance $HL=(M_1-M_0) \cdot C_2 \cdot L/I$ (Kg/cm)	Accumulative JHL = >HL (Kg/cm)	Friction Ratio (%)
0.00	0.00	0.00	0.00	0.00000	0.00	0.00	0.00
20	2.00	4.00	1.98	0.17525	3.51	3.51	8.86
40	5.00	7.00	4.94	0.17525	3.51	7.01	3.54
60	5.00	7.00	4.94	0.17525	3.51	10.52	3.54
80	10.00	13.00	9.89	0.34988	5.26	15.77	2.66
1.00	15.00	20.00	14.83	0.43813	8.76	24.54	2.95
20	20.00	25.00	19.78	0.43813	8.76	33.30	2.22
40	30.00	37.00	29.67	0.61339	12.27	45.57	2.07
60	35.00	44.00	34.61	0.78864	15.77	61.34	2.28
80	35.00	44.00	34.61	0.78864	15.77	77.11	2.28
2.00	35.00	44.00	34.61	0.78864	15.77	92.88	2.28
20	40.00	50.00	39.55	0.87627	17.53	110.41	2.22
40	40.00	50.00	39.55	0.87627	17.53	127.93	2.22
60	55.00	65.00	45.44	1.31440	26.29	154.23	2.66
80	55.00	70.00	54.39	1.31440	26.29	180.51	2.42
3.00	60.00	75.00	59.33	1.31440	26.29	206.80	2.22
20	60.00	75.00	59.33	1.31440	26.29	233.09	2.22
40	70.00	88.00	68.22	1.57728	31.55	264.63	2.28
60	80.00	100.00	79.11	1.75253	35.05	299.68	2.22
80	90.00	110.00	89.00	1.75253	35.05	334.73	1.97
4.00	95.00	115.00	93.94	1.75253	35.05	369.78	1.87
20	100.00	120.00	98.89	1.75253	35.05	404.83	1.77
40	102.00	122.00	100.86	1.75253	35.05	439.89	1.74
60	107.00	127.00	105.81	1.75253	35.05	474.94	1.66
80	110.00	130.00	108.77	1.75253	35.05	509.99	1.61
5.00	112.00	132.00	110.75	1.75253	35.05	545.04	1.59
20	115.00	135.00	113.72	1.75253	35.05	580.09	1.54
40	117.00	137.00	115.70	1.75253	35.05	615.14	1.51
60	119.00	139.00	117.67	1.75253	35.05	650.19	1.49
80	120.00	140.00	118.66	1.75253	35.05	685.24	1.48
6.00	123.00	143.00	121.63	1.75253	35.05	720.29	1.44
20	125.00	145.00	123.61	1.75253	35.05	755.34	1.42
40	126.00	156.55	124.60	1.75253	35.05	790.39	1.36
60	135.00	155.00	133.50	1.75253	35.05	825.44	1.31
80	140.00	160.00	138.44	1.75253	35.05	860.49	1.27
7.00	145.00	165.00	143.38	1.75253	35.05	895.54	1.22
20	150.00	170.00	148.33	1.75253	35.05	930.59	1.18
40	153.00	173.00	151.30	1.75253	35.05	965.64	1.16
60	155.00	175.00	153.27	1.75253	35.05	1000.69	1.14
80	158.00	178.00	156.24	1.75253	35.05	1035.75	1.12
8.00	160.00	180.00	158.22	1.75253	35.05	1070.80	1.11
20	163.00	184.00	161.18	1.84016	36.80	1107.60	1.14
40	165.00	187.00	163.16	1.92778	38.56	1146.15	1.18
60	170.00	194.00	168.11	2.10304	42.06	1188.22	1.25
80	175.00	200.00	173.05	2.19066	43.81	1232.03	1.27
9.00	180.00	205.00	177.99	2.19066	43.81	1275.84	1.23
20	185.00	210.00	182.94	2.19066	43.81	1319.66	1.20
40	200.00	225.00	197.77	2.19066	43.81	1363.47	1.11
60	225.00	250.00	222.49	2.19066	43.81	1407.28	0.98
80	240.00	265.00	237.33	2.19066	43.81	1451.10	0.92
10.00	255.00	280.00	252.16	2.19066	43.81	1494.91	0.87
20							
40							
60							
80							

Figure 3. Dutch Cone Penetrometer Test (S.01)

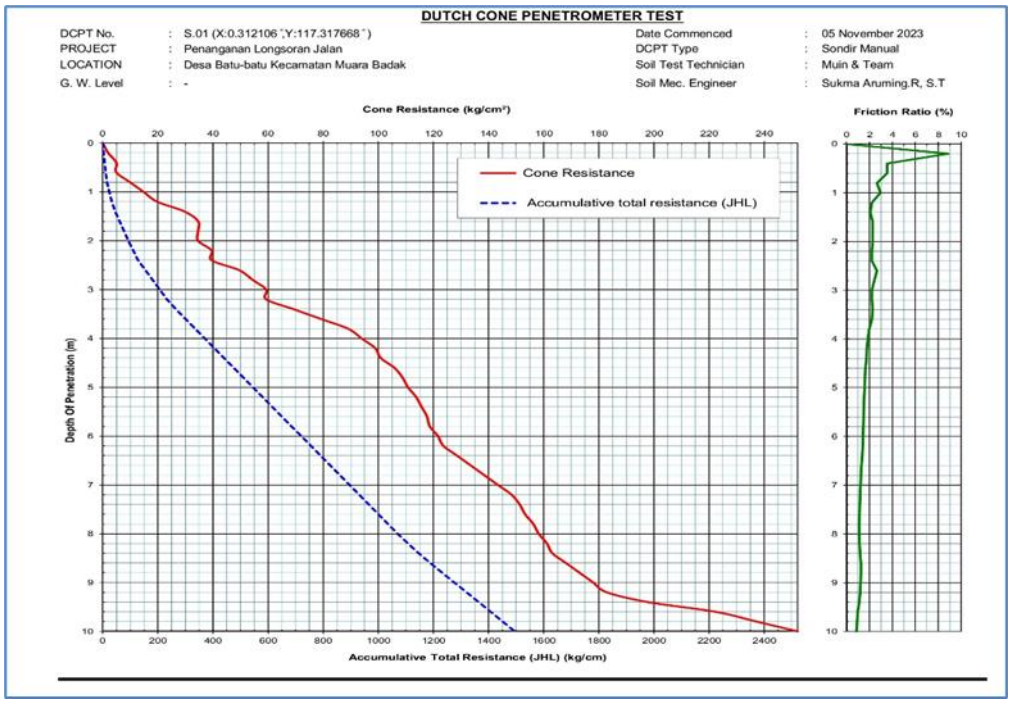
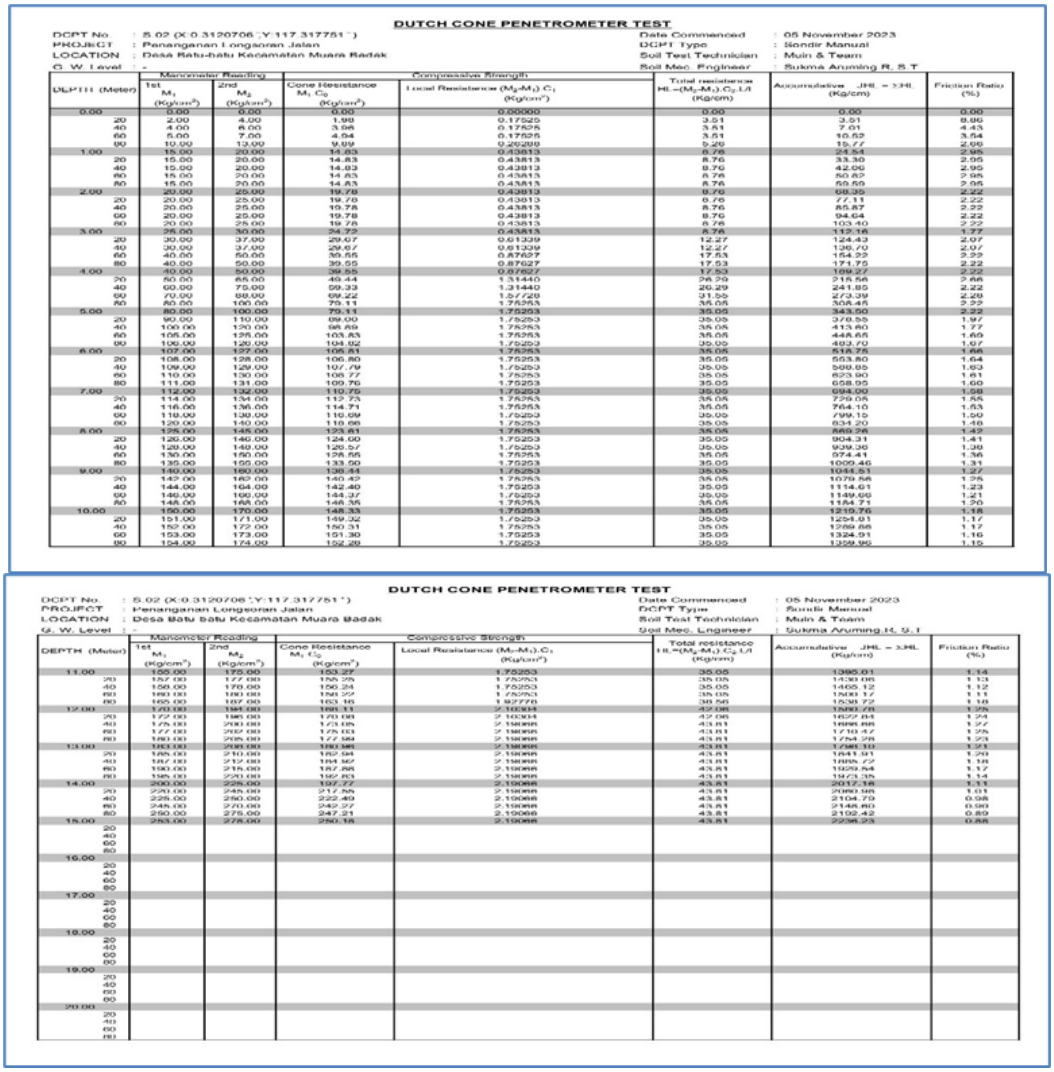


Figure 4. Pile Permit Supporting Capacity Graph



DUTCH CONE PENETROMETER TEST

DCPT No. : S.02 (X:0.3120706 °;Y:117.317751 °)
PROJECT : Penanganan Longsoran Jalan
LOCATION : Desa Batu-batu Kecamatan Muara Badak
G. W. Level : -

Date Commenced : 05 November 2023
DCPT Type : Sondir Manual
Soil Test Technician : Muin & Team
Soil Mec. Engineer : Sukma Aruming.R, S.T

DEPTH (Meter)	Manometer Reading 1st M_1 (Kg/cm²)	Manometer Reading 2nd M_2 (Kg/cm²)	Cone Resistance $M_1 C_0$ (Kg/cm²)	Compressive Strength Local Resistance $(M_2-M_1).C_1$ (Kg/cm²)	Total resistance HL=$(M_2-M_1).C_2.L/I$ (Kg/cm)	Accumulative JHL = ΣHL (Kg/cm)	Friction Ratio (%)
0.00	0.00	0.00	0.00	0.00000	0.00	0.00	0.00
20	2.00	4.00	1.98	0.17525	3.51	3.51	8.86
40	4.00	8.00	3.96	0.17525	3.51	7.01	4.43
60	5.00	7.00	4.94	0.17525	3.51	10.52	3.54
80	10.00	13.00	9.89	0.26289	5.26	15.77	2.66
1.00	15.00	20.00	14.83	0.43813	8.76	24.54	2.95
20	15.00	20.00	14.83	0.43813	8.76	33.30	2.95
40	15.00	20.00	14.83	0.43813	8.76	42.06	2.95
60	15.00	20.00	14.83	0.43813	8.76	50.82	2.95
80	15.00	20.00	14.83	0.43813	8.76	59.59	2.95
2.00	20.00	25.00	19.78	0.43813	8.76	68.35	2.22
20	20.00	25.00	19.78	0.43813	8.76	77.11	2.22
40	20.00	25.00	19.78	0.43813	8.76	85.87	2.22
60	20.00	25.00	19.78	0.43813	8.76	94.64	2.22
80	20.00	25.00	19.78	0.43813	8.76	103.40	2.22
3.00	25.00	30.00	24.72	0.43813	8.76	112.16	1.77
20	30.00	37.00	29.67	0.61339	12.27	124.43	2.07
40	30.00	37.00	29.67	0.61339	12.27	136.70	2.07
60	45.00	50.00	39.55	0.87627	17.53	154.23	2.22
80	40.00	50.00	39.55	0.87627	17.53	171.75	2.22
4.00	50.00	50.00	39.55	0.87627	17.53	189.27	2.22
20	50.00	65.00	49.44	1.31440	26.29	215.56	2.66
40	60.00	75.00	59.33	1.31440	26.29	241.85	2.22
60	70.00	89.00	69.22	1.57728	31.55	273.39	2.26
80	80.00	100.00	79.11	1.75253	35.05	308.45	2.22
5.00	80.00	100.00	79.11	1.75253	35.05	343.50	2.22
20	90.00	110.00	89.00	1.75253	35.05	378.55	1.97
40	100.00	120.00	98.89	1.75253	35.05	413.60	1.77
60	105.00	125.00	103.83	1.75253	35.05	448.65	1.69
80	100.00	120.00	104.02	1.75253	35.05	483.70	1.67
6.00	107.00	127.00	105.81	1.75253	35.05	518.75	1.66
20	108.00	128.00	106.80	1.75253	35.05	553.80	1.64
40	109.00	129.00	107.79	1.75253	35.05	588.85	1.63
60	110.00	130.00	108.77	1.75253	35.05	623.90	1.61
80	111.00	131.00	109.76	1.75253	35.05	658.95	1.60
7.00	112.00	132.00	110.75	1.75253	35.05	694.00	1.58
20	114.00	134.00	112.73	1.75253	35.05	729.05	1.55
40	116.00	136.00	114.71	1.75253	35.05	764.10	1.53
60	118.00	138.00	116.69	1.75253	35.05	799.15	1.50
80	120.00	140.00	118.68	1.75253	35.05	834.20	1.48
8.00	125.00	145.00	123.61	1.75253	35.05	869.26	1.42
20	126.00	146.00	124.60	1.75253	35.05	904.31	1.41
40	128.00	148.00	126.57	1.75253	35.05	939.36	1.38
60	130.00	150.00	128.55	1.75253	35.05	974.41	1.36
80	135.00	155.00	133.50	1.75253	35.05	1009.46	1.31
9.00	140.00	160.00	138.44	1.75253	35.05	1044.51	1.27
20	142.00	162.00	140.42	1.75253	35.05	1079.56	1.25
40	144.00	164.00	142.40	1.75253	35.05	1114.61	1.23
60	146.00	166.00	144.37	1.75253	35.05	1149.66	1.21
80	148.00	168.00	146.35	1.75253	35.05	1184.71	1.20
10.00	150.00	170.00	148.33	1.75253	35.05	1219.76	1.18
20	151.00	171.00	149.32	1.75253	35.05	1254.81	1.17
40	152.00	172.00	150.31	1.75253	35.05	1289.86	1.17
60	153.00	173.00	151.30	1.75253	35.05	1324.91	1.16
80	154.00	174.00	152.28	1.75253	35.05	1359.96	1.15

Figure 5. Dutch Cone Penetrometer Test (S.02)

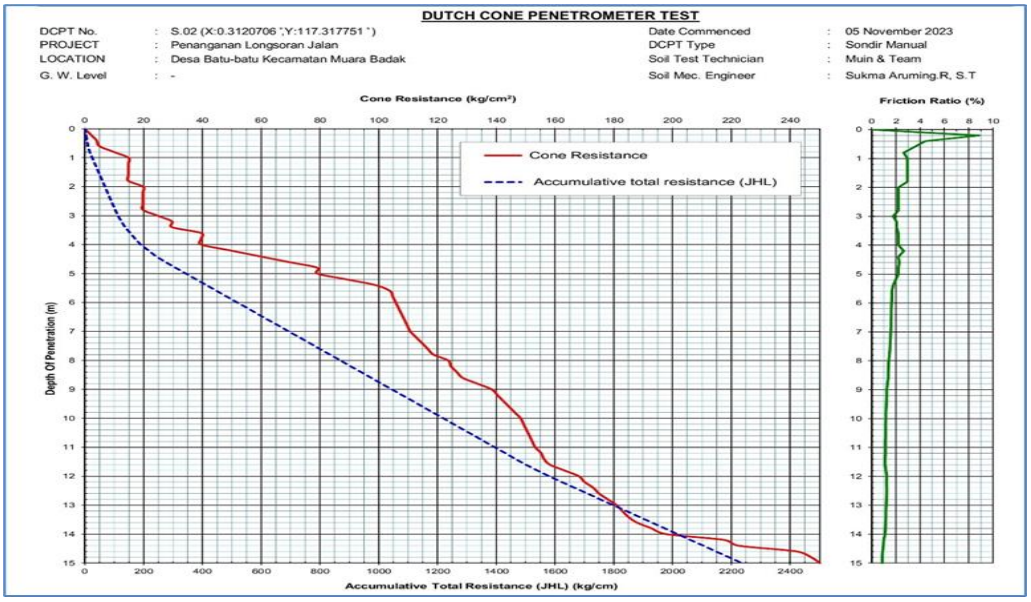


Figure 6. Pile Permit Supporting Capacity Graph

DUTCH CONE PENETROMETER TEST

DCPT No.	: S.03 (X:0.312038 °;Y:117.317832 °)	Date Commenced	: 05 November 2023
PROJECT	: Penanganan Longsoran Jalan	DCPT Type	: Sondir Manual
LOCATION	: Desa Batu-batu Kecamatan Muara Badak	Soil Test Technician	: Muin & Team
G. W. Level	: -	Soil Mec. Engineer	: Sukma Aruming,R, S.T

DEPTH (Meter)	Manometer Reading 1st M_1 (Kg/cm²)	Manometer Reading 2nd M_2 (Kg/cm²)	Compressive Strength: Cone Resistance $M_1.C_0$ (Kg/cm²)	Compressive Strength: Local Resistance $(M_2-M_1).C_1$ (Kg/cm²)	Total resistance $HL=(M_2-M_1).C_2.L/I$ (Kg/cm)	Accumulative JHL = ΣHL (Kg/cm)	Friction Ratio (%)
0.00	0.00	0.00	0.00	0.00000	0.00	0.00	0.00
20	2.00	4.00	1.98	0.17525	3.51	3.51	8.86
40	5.00	7.00	4.94	0.17525	3.51	7.01	3.54
60	10.00	13.00	9.89	0.26288	5.26	12.27	2.66
80	15.00	20.00	14.83	0.43813	8.76	21.03	2.95
1.00	15.00	20.00	14.83	0.43813	8.76	29.79	2.95
20	20.00	25.00	19.78	0.43813	8.76	38.56	2.22
40	30.00	37.00	29.67	0.61339	12.27	50.82	2.07
60	40.00	50.00	39.55	0.87627	17.53	68.35	2.22
80	50.00	65.00	49.44	1.31440	26.29	94.64	2.66
2.00	50.00	65.00	49.44	1.31440	26.29	120.92	2.66
20	50.00	65.00	49.44	1.31440	26.29	147.21	2.66
40	50.00	65.00	49.44	1.31440	26.29	173.50	2.66
60	50.00	65.00	49.44	1.31440	26.29	199.79	2.66
80	50.00	65.00	49.44	1.31440	26.29	226.08	2.66
3.00	50.00	65.00	49.44	1.31440	26.29	252.36	2.66
20	60.00	75.00	59.33	1.31440	26.29	278.65	2.22
40	60.00	75.00	59.33	1.31440	26.29	304.94	2.22
60	70.00	88.00	69.22	1.57728	31.55	336.49	2.28
80	70.00	88.00	69.22	1.57728	31.55	368.03	2.28
4.00	70.00	88.00	69.22	1.57728	31.55	399.58	2.28
20	80.00	100.00	79.11	1.75253	35.05	434.63	2.22
40	80.00	100.00	79.11	1.75253	35.05	469.68	2.22
60	90.00	110.00	89.00	1.75253	35.05	504.73	1.97
80	90.00	110.00	89.00	1.75253	35.05	539.78	1.97
5.00	100.00	120.00	98.89	1.75253	35.05	574.83	1.77
20	101.00	121.00	99.87	1.75253	35.05	609.88	1.75
40	103.00	123.00	101.85	1.75253	35.05	644.93	1.72
60	104.00	124.00	102.84	1.75253	35.05	679.98	1.70
80	105.00	125.00	103.83	1.75253	35.05	715.03	1.69
6.00	105.00	125.00	103.83	1.75253	35.05	750.08	1.69
20	105.00	125.00	103.83	1.75253	35.05	785.13	1.69
40	106.00	126.00	104.82	1.75253	35.05	820.18	1.67
60	108.00	128.00	106.80	1.75253	35.05	855.23	1.64
80	110.00	130.00	108.77	1.75253	35.05	890.29	1.61
7.00	110.00	130.00	108.77	1.75253	35.05	925.34	1.61
20	112.00	132.00	110.75	1.75253	35.05	960.39	1.58
40	114.00	134.00	112.73	1.75253	35.05	995.44	1.55
60	116.00	136.00	114.71	1.75253	35.05	1030.49	1.53
80	118.00	138.00	116.69	1.75253	35.05	1065.54	1.50
8.00	120.00	140.00	118.66	1.75253	35.05	1100.59	1.48
20	123.00	143.00	121.63	1.75253	35.05	1135.64	1.44
40	125.00	145.00	123.61	1.75253	35.05	1170.69	1.42
60	130.00	150.00	128.55	1.75253	35.05	1205.74	1.36
80	135.00	155.00	133.50	1.75253	35.05	1240.79	1.31
9.00	140.00	160.00	138.44	1.75253	35.05	1275.84	1.27
20	145.00	165.00	143.38	1.75253	35.05	1310.89	1.22
40	150.00	170.00	148.33	1.75253	35.05	1345.94	1.18
60	155.00	175.00	153.27	1.75253	35.05	1380.99	1.14
80	157.00	177.00	155.25	1.75253	35.05	1416.04	1.13
10.00	160.00	180.00	158.22	1.75253	35.05	1451.10	1.11
20	162.00	183.00	160.20	1.84016	36.80	1487.90	1.15
40	163.00	184.00	161.18	1.84016	36.80	1524.70	1.14
60	165.00	187.00	163.16	1.92778	38.56	1563.26	1.18
80	167.00	190.00	165.14	2.01541	40.31	1603.57	1.22

Figure 7. Dutch Cone Penetrometer Test (S.03)

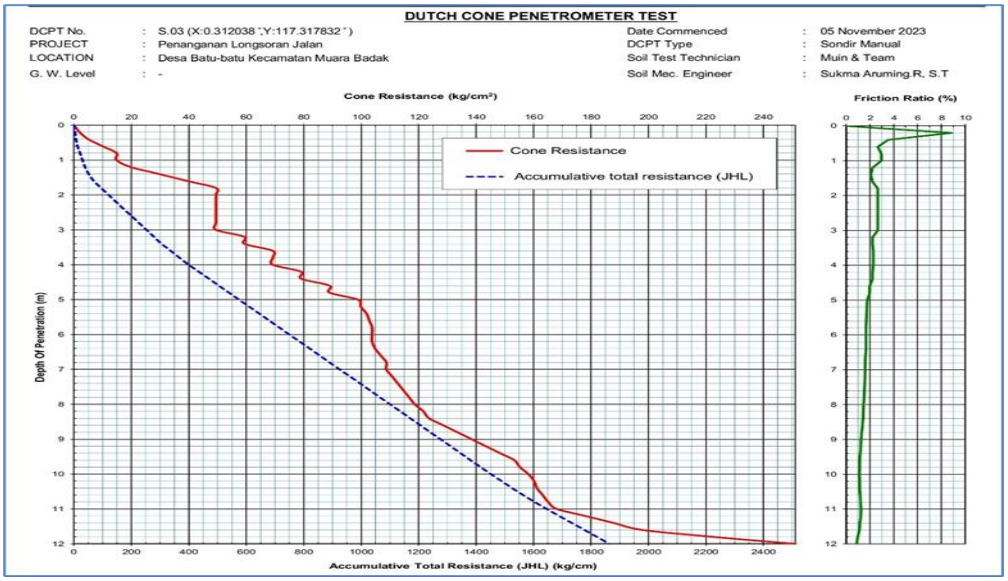


Figure 8. Pile Permit Supporting Capacity Graph

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the soil tests carried out, several main findings were obtained as follows: The results of the Sondir Test showed that the soil conditions at the three test points had a variation in density from very soft to hard, with hard soil found at varying depths:

Sondir 01: from a depth of 7.30 m to >10.00 m.

Sondir 02: from a depth of 10.30 m to >15.00 m.

Sondir 03: from a depth of 9.50 m to >12.00 m.

Foundation Analysis shows that the recommended type of foundation is a deep foundation, such as piles or bore piles, according to the bearing capacity of the soil and the accepted construction load.

Foundation Selection: Considering that hard soil is only found at a depth of ≥7 m, the use of deep foundations such as piles or bore piles is more recommended to ensure the stability of the building structure.

Foundation Carrying Capacity: The calculation of the bearing capacity of the foundation must be carried out by considering the critical value of the sondir results, as well as taking into account the load capacity that will be received by the building structure.

Strengthening the Bottom Soil: If a shallow foundation is required, then soil improvements such as compaction or stabilization of the soil with additional materials should be considered in order to increase the carrying capacity of the soil.

Selection of Backfill Material: The backfill material used must meet the density standards and CBR values according to the provisions, especially for areas that require high carrying capacity.

Soil Condition Monitoring: It is recommended to conduct further monitoring of soil conditions, especially in large construction projects, to ensure that no soil subsidence may occur that could affect the stability of the structure.

FURTHER STUDY

This research still has limitations so further research is needed on the topic of Soil Investigation in Batu – Batu Village: Geotechnical Analysis to increase insight for readers and writers.

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